

## **Cooperative R&D in the Sugar Industry**

Vadim Kochergin

Amalgamated Research Inc., P.O. Box 228, Twin Falls, Idaho 83303-0228

### **Abstract**

Creation of reliable new process technologies, validation of new equipment and process troubleshooting in the sugar industry often requires long-term research and development (R&D). The latter is especially important due to specific features of the sugar industry, such as the variable composition of feed streams, multicomponent mixtures, little-known interactions between many components of industrial solutions, etc. Such R&D efforts are generally quite expensive and may be deemed unnecessary, especially because of the present difficult economic situation in the sugar industry. Cooperation in R&D programs on strategically important projects is believed to be an efficient tool to guarantee future development of the industry. Joint efforts of different research centers will ensure the best quality R&D and the best return on investment for industrial partners. The cooperation of several sugar producers and equipment manufacturers on the development of the new raw juice purification project is used as an example of a successful research program. The benefits and drawbacks of joint R&D programs are addressed.

### **Introduction**

It is well known that progress of any industry depends on the level of investment in research and development. Ironically R&D centers are the first to be sacrificed during difficult economic situations. Following this pattern in recent years the U.S. sugar industry has reduced the number of research departments and centers to a bare minimum. As a result, the load of technology development has shifted to industry suppliers who are also hurting economically during the sugar industry slowdown. However, low sugar prices, growing pressure from environmental agencies and other factors force the industry to seek innovative ideas to guarantee its survival. In such situations cooperation in R&D on strategically important technologies becomes imperative.

Both fundamental and applied R&D projects may be conditionally divided into two categories according to their scope. An individual company can typically handle smaller projects. The projects comprising several unit operations, where there is a need to evaluate the influence of new technology on the whole process typically require long-term studies. Such projects minimize risks involved in the commercialization of new technologies. Similarly fundamental projects that do not promise fast economic return may be jointly sponsored by several companies, thus minimizing the cost of research studies.

### **Why cooperation?**

Since most sugar beet factories in the world use essentially the same technology, the sugar industry have been advancing either through development of new equipment or modification and reconfiguration of existing schemes. Optimization of evaporators, pan automation, testing of new centrifuges and modification of juice purification are good examples of such development. During the last few decades development of new and less expensive polymers and new materials has opened up new opportunities for sugar technologists.

Chromatographic desugarization of molasses, juice softening, reverse osmosis of dilute sugar streams, ion exchange decolorization and membrane filtration represent new and emerging technologies within the sugar industry. The latest developments are directed towards the alteration of large segments of sugar processing technology. Among them are raw juice purification technology applied both to raw beet juice and clarified cane juice (ARi, USA), cooling crystallization of raw beet juice (University of Ferrara, Italy), combination of ultra- and nanofiltration for decolorization of cane syrups (Audubon Sugar Institute, USA), etc. These technologies are yet to be implemented on the full-scale because of difficulties of integration into existing plants and availability of capital. The work is continued to reduce the required capital investment.

The following factors that are specific to the sugar industry emphasize the importance of long-term research to develop reliable new technologies.

- The quality of process streams is changing depending on various beet growing areas, beet storage conditions, seasonal variations, etc.
- Besides major components, such as sucrose and inorganic salts, industrial sugar solutions contain dozens of other components. If a new process affects the distribution of these components, the consequences are difficult to predict.
- The new processes should be custom tailored to the configuration of a particular sugar plant (existing equipment, beet and sugar end capacity, etc.)
- Certain features of new processes or equipment can only be observed after long-term exposure to the process fluids. For example, a membrane surface can be eroded over a period of time or bacterial film may grow on the permeate side of a membrane. If these issues are not addressed in the research phase of a project, the consequences may be very costly on the industrial scale.

Lack of funds or expertise may lead to an improperly conducted research program, result in wrong conclusions and eventually compromise a potentially useful technology. It is even more dangerous, when the results are too optimistic due to insufficient research data. The resulting failure of a technology on the industrial scale creates a precedent and such technology can be abandoned for many years. It is important to realize that rapid development of certain branches of science changes the market situation drastically; therefore, certain technologies must be revisited regularly to evaluate their feasibility. A good example would be chromatographic technology, which had been considered cost prohibitive for many years until resin cost and new developments made it one of the most feasible processes ever applied in the sugar industry. A similar situation is observed with application of membrane filtration processes. Although the sugar industry was among the first to explore membrane filtration, only during recent years have new generations of membranes finally made this technology economically attractive.

## **Benefits of cooperation**

### *Project cost*

A convincing example favoring cooperation in R&D projects is illustrated by the data in Table 1. The data represent a cost estimate for an R&D project requiring continuous operation of pilot equipment for a period of one campaign. The numbers may vary greatly depending on the scope of the project. The cost can easily double if a project involves more than one unit

operation. Our experience shows that the cost of such projects may range from \$150,000 to \$400,000 per campaign. It is quite obvious that very few companies can afford an R&D project of such scope, especially for more than one campaign. The project, however, becomes quite affordable if 8-10 companies pool their resources to sponsor it.

**Table 1**  
**Estimated cost of a large R&D project for a 150 day campaign**

Temporary operators' labor	\$50,000
Engineering supervision and overhead	\$50,000
Energy, chemicals, misc. supplies	\$5,000
Installation and maintenance	\$15,000
Rental equipment	\$50,000
Transportation and shipping	\$5,000
Analytical support	\$10,000
<b>Total</b>	<b>\$185,000</b>

#### *Expertise*

Cooperation allows taking advantage of specialists having expertise in the studied subject. Some research centers traditionally have better expertise in certain areas than the others. Forming a multidisciplinary group will bring together the best experience available in the industry. This will also allow reducing a project time line by shortening the learning curve. Contribution of ideas and experience from specialists with various backgrounds will guarantee the highest quality research.

#### *Spin-off ideas*

The atmosphere of innovation and creativity exhibited with cooperative R&D studies gives rise to an important benefit – spin-off projects. Certain technologies studied in the course of a joint R&D project may be either altered by individual companies for their own benefit or used in different applications. When conceived by an individual company, spin-off ideas are not necessarily shared with the rest of the group. This assures that cooperative R&D does not jeopardize competition. Although the companies unite their efforts in one area, each participant will use the results to complement its own strategy.

#### *Relationship with vendors and suppliers*

Usually a given technology is available from several industry suppliers. New equipment may be offered for testing to a single company. The short-term nature of such a relationship does not necessarily benefit either of the partners or the industry as a whole. However, a group of companies involved in a similar project has the advantage of testing several competitive products. Such a group attracts serious vendors who are committed to equipment and technology development. It is especially important that testing proceeds beyond the performance of “off the shelf” products, and continues with development of products specifically tailored for the industry. A mutually beneficial development partnership with vendors can be much more fruitful than traditional “seller-buyer” relationships.

### *Availability to members only and accountability*

Unless agreed otherwise, the results of a joint research projects are available only to sponsors. A sponsor agreement should clearly outline the expected goals and specify the life of a project. A company or a group of companies acting as project manager takes the responsibility of insuring that results are distributed only between members. If sponsors are not satisfied with results they may be free to cancel their membership at any time. The fact that the sponsorship is not guaranteed for any specific year assures high quality R&D, because it increases the accountability of the company serving as project manager.

### *No unnecessary duplication*

Duplication and incomplete research by individual companies often leads to controversial results and a waste of resources. However, duplication of research efforts can be an extremely useful tool for validating results generated by various research groups. It is rather easy to organize "useful" duplication within a joint R&D program.

## **Concerns**

### *Competition*

Competitive issues remain a major concern of companies participating in joint R&D projects. Justification of such projects is particularly difficult for companies which have their own R&D departments. However, joint research may provide useful diversification at a relatively low cost. Spin-off ideas (discussed above) guarantee enough versatility to resolve competitive issues. As a matter of fact, a group of companies, which joins resources for cooperative research, automatically become more competitive in the area of study.

### *Why not buy it later?*

Another important concern can be expressed as follows: "Why should we participate in the development, if the technology (or equipment) will be available in the market later anyway? We will buy it when it is ready and verified on an industrial scale." The answer certainly depends on a company's general philosophy. However, the "industrial scale" learning curve is obviously much more expensive than on the pilot scale. In the course of an R&D study the participants gain useful expertise in the developing technology, which would not be available otherwise. Obviously during commercialization of such technology the participants will have a technical advantage. Furthermore, the technology available for sale is likely to be more expensive in the end. It is logical to expect the vendors or developers to recover their R&D expenses. Another possibility is that a technology developed by a certain group will remain the property of this group and may not be available for sale at all.

### *Ownership and patent issues*

The ownership of results generated in the course of a joint project will generally belong to the member companies. They may need to decide whether to apply for a joint patent(s) or maintain knowledge as a trade secret between the participating companies. These issues should be addressed carefully, especially in cases when the group size changes over the life of the project. The issue of ownership of equipment purchased in the course of a joint research project also must be properly addressed.



## Forms of cooperation

The forms of cooperation may depend on the scope of the project and expected project life. Various forms may also be used as needed in the course of the study. For example a project started as a cooperation between several sugar companies may at some stage involve an R&D center or a supplier as a cooperative partner. Examples of cooperation include:

- Several sugar companies joining forces to test certain equipment in several factories in order to learn how local conditions affect the equipment performance.
- An R&D center chosen as project manager leads the efforts of several companies in technology development.
- Larger projects requiring more expertise in several different areas and requiring cooperation between research centers within the beet industry.
- Projects needed for the survival of the whole industry, which bring together a multidisciplinary R&D consortium and require cooperation between many companies and R&D centers in both the beet and cane sugar industries.

The following sequence is proposed to create a joint R&D program.

- *Define the new technology or technical improvement of interest*
- *Estimate required funding*
- *Define critical project, for which companies are willing to cooperate*
- *Create a consortium and bring in the best expertise available*
- *Test and develop the critical unit operations within the consortium*
- *Expect each company to follow its own directions after the project is completed*

## Examples of cooperation

The Sugar Processing Research Institute (SPRI) is a good example of an organization that has been providing research and development for the sugar industry for many years. Besides the contribution from members the company is sponsored by the U.S. Government. SPRI's most important feature is that it addresses issues for the whole sugar industry including beet and cane factories and sugar refineries. Traditionally SPRI has been involved in fundamental studies.

A consortium of eight international companies together with Amalgamated Research Inc. (ARi) as project manager serves as an example of successful cooperation in the field of new technology development. The companies were attracted to the idea of lime-free juice purification proposed by ARi. The technology includes the following stages: clarification, membrane filtration, juice softening, evaporation and chromatography. Among the unit operations membrane technology appears to present more challenges than the other unit processes. Evaluation of membrane life and modes of failure are critical study that cannot be accomplished in a short-term test program. Juice pretreatment and handling of effluent streams, optimization of membrane cleaning procedures, equipment design and the other operating and design issues need to be addressed in a long-term study simulating factory operation.

Although ARi is one of the suppliers of chromatographic technology, the company is not affiliated with any membrane suppliers. This has allowed the Group to have full access to any membrane available on the market. While cooperatively searching for the best membrane suitable for raw juice filtration, each member company has its own strategic goals.

## Conclusions

- Cooperative research and development of strategically important technologies can help address issues critical for industry survival.
- Cost sharing lowers economic risk involved in project development.
- Partnership with equipment and product suppliers on the issues addressing industry wide problems is one key for effective development.
- Cooperation between various research centers is essential for bringing together the best expertise available in the industry.
- The expertise accumulated in the course of joint R&D projects allows member companies to make intelligent decisions during commercialization of the developed technologies.